CLAIMS

1. An eddy current sensor comprising:

a sensor coil disposed near a conductive film formed on a substrate;

a signal source configured to supply an AC signal to said sensor coil to produce an eddy current in the conductive film;

a detection circuit operable to detect the eddy current produced in the conductive film, said detection circuit being connected to said sensor coil; and

a housing made of a material having a high magnetic permeability, said housing accommodating said sensor coil therein.

2. The eddy current sensor as recited in claim 1, wherein said housing has a cylindrical shape.

3. The eddy current sensor as recited in claim 1, wherein said sensor coil comprises:

an excitation coil operable to produce an eddy current in the conductive film; and

a detection coil operable to detect the eddy current produced in the conductive film.

4. The eddy current sensor as recited in claim 3, wherein said sensor coil further comprises a balance coil operable to adjust a zero point of a detection output in cooperation with said detection coil.

5. The eddy current sensor as recited in claim 1, wherein said housing is disposed within a conductive member.

6. An eddy current sensor comprising:

a sensor coil disposed near a conductive film formed on a substrate;

a signal source configured to supply an AC signal to said sensor coil to produce an eddy current in the conductive film;

a detection circuit operable to detect the eddy current produced in the conductive film, said detection circuit being connected to said sensor coil; and

an insulating member accommodating said sensor coil therein, said insulating member being embedded in a conductive material.

7. An eddy current sensor comprising:

a sensor coil disposed near a conductive film formed on a substrate;

a signal source configured to supply an AC signal to said sensor coil to produce an eddy current in the conductive film;

a detection circuit operable to detect the eddy current produced in the conductive film based on an impedance as viewed from said sensor coil; and

a controller configured to specify a point including a resistance component and a reactance component of the impedance in rectangular coordinates and to detect film thickness of the conductive film from an angle formed by a line connected between the point and the a predetermined central point in the rectangular coordinates.

8. The eddy current sensor as recited in claim 7, wherein said controller is configured to detect the film thickness of the conductive film from the angle without influence due to a distance between said sensor coil and the conductive film.

9. The eddy current sensor as recited in claim 7, wherein the predetermined central point is calibrated by a calibration data table including film thicknesses and resistance components (Xm) and reactance components (Ym) corresponding to the film thicknesses.

10. An eddy current sensor comprising:

a sensor coil disposed near a first conductive film formed on a substrate;

a signal source configured to supply an AC signal to said sensor coil to produce an eddy current in the first conductive film;

a detection circuit operable to detect the eddy current produced in the first conductive film based on an impedance as viewed from said sensor coil; and

a controller configured to specify first impedance coordinates of a resistance component and a reactance component of the impedance in rectangular coordinates and to perform phase rotation, parallel displacement, and expansion on the first impedance coordinates.

11. The eddy current sensor as recited in claim 10, wherein the controller is configured to perform phase rotation to conform second impedance coordinates of an impedance of a second conductive material to an axis of the rectangular coordinates and expansion to obtain a change of the first impedance coordinates of the impedance of the first conductive material in an enlarged manner when the first impedance coordinates are influenced by the second impedance coordinates.

12. The eddy current sensor as recited in claim 11, wherein the second conductive film comprises a semiconductor wafer,

wherein the first conductive film comprises a barrier layer or a metal film formed on the semiconductor wafer.

13. An eddy current sensor comprising:

a sensor coil disposed near a conductive film formed on a substrate;

a signal source configured to supply an AC signal to said sensor coil to produce an eddy current in the conductive film;

a detection circuit operable to detect the eddy current produced in the conductive film based on an impedance as viewed from said sensor coil;

a storage device operable to store a correction coefficient according to a deposition condition of the conductive film; and

a controller configured to specify a point including a resistance component and a reactance component of the impedance in rectangular coordinates and to correct the point by the correction coefficient stored in said storage device.

14. The eddy current sensor as recited in any one of claims 10 through 13, wherein said controller is configured so that the resistance component and the reactance component are constant when film thickness of a reference conductive film is measured.

15. An eddy current sensor comprising:

a sensor coil disposed near a conductive film formed on a substrate;

a signal source configured to supply an AC signal to said sensor coil to produce an eddy current in the conductive film;

a detection circuit operable to detect the eddy current produced in the conductive film based on an impedance as viewed from said sensor coil; and

a controller configured to specify an impedance coordinates of a resistance component and a reactance component of the impedance in rectangular coordinates and to move the impedance coordinates on a semicircular locus in the rectangular coordinates according to progress of a process.

16. The eddy current sensor as recited in claim 15, wherein said controller is configured to calculate a change of the film thickness of the conductive film based on length of an arc on which the impedance coordinates move.

17. The eddy current sensor as recited in claim 16, wherein the length of the arc is not influenced by conductivity of the substrate.

18. The eddy current sensor as recited in claim 15, wherein the impedance dramatically varies along one of axes in the rectangular coordinates,

wherein said controller is configured to select the one of axes in the rectangular coordinates.

19. The eddy current sensor as recited in claim 15, wherein the impedance coordinates are configured to be set by an offset, an amplification degree, phase rotation, or polarity selection of a main amplifier.

20. The eddy current sensor as recited in claim 15, wherein said controller is configured to measure the impedance coordinates every predetermined time and to detect an endpoint of a process based on a correlation between an impedance characteristic and model data.

21. The eddy current sensor as recited in claim 15, wherein said controller is configured to predict a remaining time until an endpoint of a process.

22. The eddy current sensor as recited in claim 15, wherein the the substrate is held by a substrate holding device having a conductive member located away from said sensor coil so that the conductive member has no influence on the eddy current produced in the conductive film.

23. An eddy current sensor comprising:

a sensor coil disposed near a substrate having a plurality of zones;

a signal source configured to supply an AC signal to said sensor coil to produce an eddy current in the substrate;

a detection circuit operable to obtain signal data on the eddy current produced in the plurality of zones of the substrate; and

a controller configured to detect an endpoint of a process based on the signal data.

24. The eddy current sensor as recited in claim 23, wherein said controller is configured to employ a determination value including a value of signal data on an optimum zone of the plurality of zones, an average value of the signal data on the plurality of zones, an average value of the signal data on a desired combination of the plurality of zones, an effective value, a first time-derivative of the signal data, a second time-derivative of the signal data, and a *n*th time-derivative of the signal data and to compare the determination value with a predetermined value to detect the endpoint of the process.

25. The eddy current sensor as recited in claim 23, wherein said controller is configured to perform an edge cutting process on the signal data,

wherein the signal data includes X and Y components of an impedance, a phase θ, a synthesis impedance Z, a frequency F, and a film thickness value converted therefrom.

26. The eddy current sensor as recited in claim 23, wherein said controller is configured to perform an arithmetical operation on a reference time, which is calculated from the signal data, with a coefficient to calculate an additional period of process time and add the additional period of process time to the reference time so as to detect the endpoint of the process.

27. A substrate processing apparatus comprising:

a processing device configured to process the substrate; and

the eddy current sensor as recited in any one of claims 1 through 26.

28. A polishing apparatus comprising:

a polishing surface;

a substrate holding device configured to hold the substrate and press the substrate against said polishing surface; and

the eddy current sensor as recited in any one of claims 1 through 26.

29. A substrate deposition apparatus comprising:

a substrate deposition device configured to deposit a conductive film on the substrate; and

the eddy current sensor as recited in any one of claims 1 through 26.